MSV
Mobile Satellite Ventures

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August 31, 2004

Via Hand Delivery
Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

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Federal Communications Commission
Office of Secretary

> Re: **Mobile Satellite Ventures Subsidiary LLC**
> **IB Docket No. 01-185**
> **File No. SAT-MOD-20031118-00333**
> **File No. SAT-AMD-20031118-00332**
> **File No. SES-MOD-20031118-01879**

Dear Ms. Dortch:

Mobile Satellite Ventures Subsidiary LLC ("MSV") hereby files the attached paper entitled "Technical Considerations for Measuring the Receiver Overload Threshold of an Inmarsat Mobile Earth Terminal (MET)" in the above-captioned proceedings.

Please direct any questions regarding this matter to the undersigned.

Very truly yours,

Lon C. Levin
Vice President

cc: Chip Fleming
     Howard Griboff
     Kathyrn Medley
     Sean O'More

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Technical Considerations for Measuring the Receiver Overload Threshold of an Inmarsat Mobile Earth Terminal (MET)

August 30, 2004

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Introduction: In a memorandum dated June 25, 2004, the Commission advised MSV of its intent to perform measurements on Inmarsat Mobile Earth Terminal (MET) receivers, using simulated interfering signals at various power levels and frequency offsets. This paper outlines technical considerations that MSV regards as essential to ensure meaningful results. The Commission's staff is encouraged to communicate further with MSV in the event additional clarification is needed. The technical points of contact at MSV are: Peter D. Karabinis; VP & CTO; pkarabinis@msvlp.com; phone: (703) 980-0768; and Gary G. Churan; Technical Director; gchuran@msvlp.com; phone: (703) 390-2707.

I.   **Interfering Signal Parameters:** The following signal types are candidates for deployment in MSV's ATC base stations, and therefore should be evaluated in the Commission's tests:

   A.   **GSM-compatible Offset-QPSK Signal Parameters:**
      Modulation Type: -------   OQPSK
      Symbol Rate: -------------   135.44 ksps
      Filter Type: ---------------   Root-Nyquist
      Filter Shape (alpha):   -----   0.3

   B.   **cdma2000-1X Signal Parameters:**
      Modulation Type: ---------   DS-spread spectrum
      Chip Rate: -------------------   1228.8 kcps
      Carrier Bandwidth: ---------   1.25 MHz

   C.   **W-CDMA Signal Parameters:**
      Modulation Type: ---------   DS-spread spectrum
      Chip Rate: -------------------   3.84 Mcps
      Carrier Bandwidth: --------   5.0 MHz

   D.   **WiMAX Signal Parameters:**
      Modulation Type: -- OFDMA
      Number of Sub-Carriers: -- 256
      Frequency separation between sub-carriers (center-to-center): -- 4.8 kHz
      Carrier Bandwidth: --- 1.25 MHz

   E. **Out-of-Channel Emissions:** In order to protect Inmarsat METs that may be operative proximate to ATC base stations, MSV has committed to going beyond the requirements of Section 25.253(b) with respect to the Out-of-Channel Emissions (OOCE) EIRP power spectral density limit the FCC established for base station sectors. Independent of the number of carriers that may be deployed per base station sector, the EIRP that may be radiated per carrier, and the type of waveform/protocol that may be used, MSV has committed not to exceed -57.9 dBW/MHz OOCE EIRP density per sector. *See* Letter from Bruce D. Jacobs, Counsel for MSV, to Ms. Marlene H. Dortch, FCC, File No. SAT-MOD-20031118-00333 et al (February 4, 2003), Attachment at 16. As such, in subjecting an Inmarsat channel/MET to

overload interference, the Commission must adhere to the above specified aggregate OOCE EIRP density limit irrespective of the interfering waveform/protocol and/or the number of carriers being used to subject the Inmarsat channel/MET to overload interference. Thus, for example, if a test is using a single interfering carrier with an EIRP of 19.1 dBW, the carrier's OOCE EIRP density into an Inmarsat channel/MET that is being subjected to overload interference should not exceed -57.9 dBW/MHz. If more than one interference carrier is being used in a test, the aggregate OOCE EIRP density into the Inmarsat channel/MET being subjected to overload interference should still not exceed -57.9 dBW/MHz. If the specified aggregate OOCE EIRP density limit is not satisfied, the overload measurements will be biased by excessive co-channel interference and the test results will be erroneous and invalid. (Instead of reflecting the impact of overload interference, the test results will reflect the composite effect of overload interference and co-channel interference). It should be noted that the appropriate setting of the aggregate OOCE EIRP density level (-57.9 dBW/MHz) and the level of the interfering carrier EIRP (i.e., 19.1 dBW) should be established at the output of the signal generator(s) providing the interference carrier(s). Having done so, any attenuation that may be imposed on the aggregate interfering signal (interfering carrier(s) and aggregate OOCE EIRP density), will influence equally the EIRP of the interfering carrier(s) as well as the aggregate OOCE EIRP density.

II. **Test Configuration**: It is MSV's understanding that, in order to maintain control and repeatability of channel/signal parameters during the measurements, the Commission's testing will be performed in a laboratory environment, using a gateway/satellite simulator (provided to the Commission by Inmarsat) to generate the required Inmarsat signaling and traffic carriers.

Inmarsat terminals are typically constructed with an antenna and a Radio Frequency Unit (RFU) which is connected by coaxial cable to a separate modem/baseband unit. The interfering and desired signal levels should be referenced to the antenna output of the MET under test. In this regard, we anticipate that two possible terminal configurations may need to be accommodated:

A. **Antenna Separable from RFU**: This configuration is preferred because it allows direct access to the front-end input, which minimizes measurement uncertainty. A conceptual block diagram for this case is shown in Fig. 1 below. The antenna is removed and the signal (desired plus interference) is injected directly in the RFU at the point where the RFU connects to the antenna output port (at the point labeled P_{in}).

Fig. 1: Test Set-Up for Removable Antenna
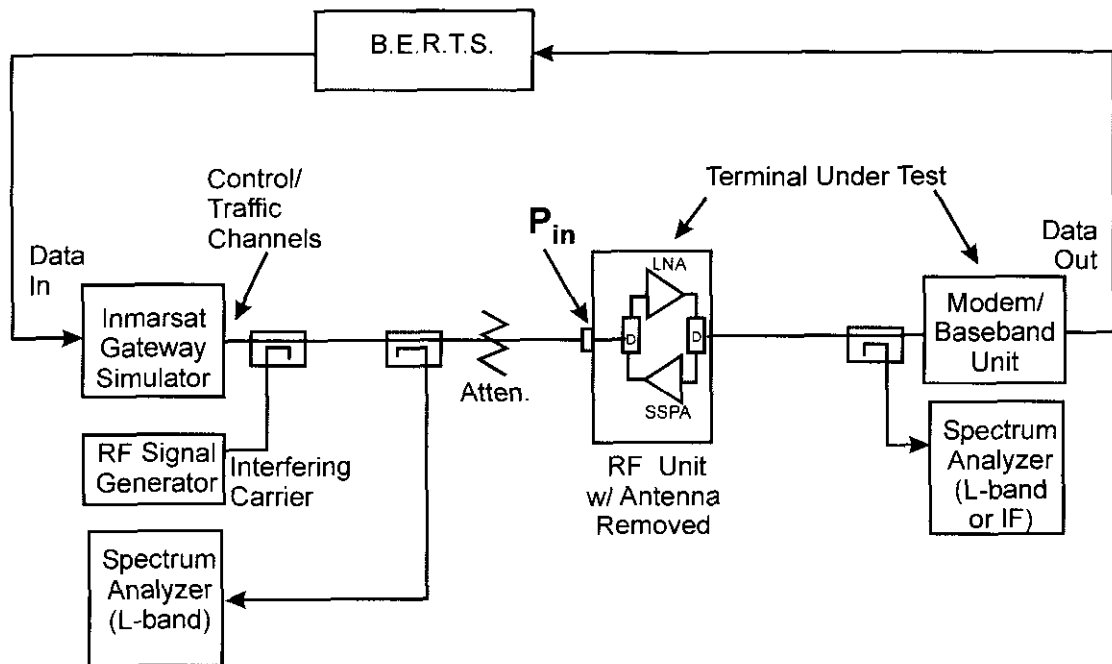
B. Antenna Integrated with RFU: In some terminal models (such as Mini-M "notebook" types), the antenna and RFU are integrated into a common sealed package, so that the antenna output port cannot be accessed directly short of destructively disassembling the unit. In this case, the required front-end input signal levels can be established using an anechoic chamber configuration as shown in Fig. 2:

Fig. 2: Test Set-Up for Integrated Antenna
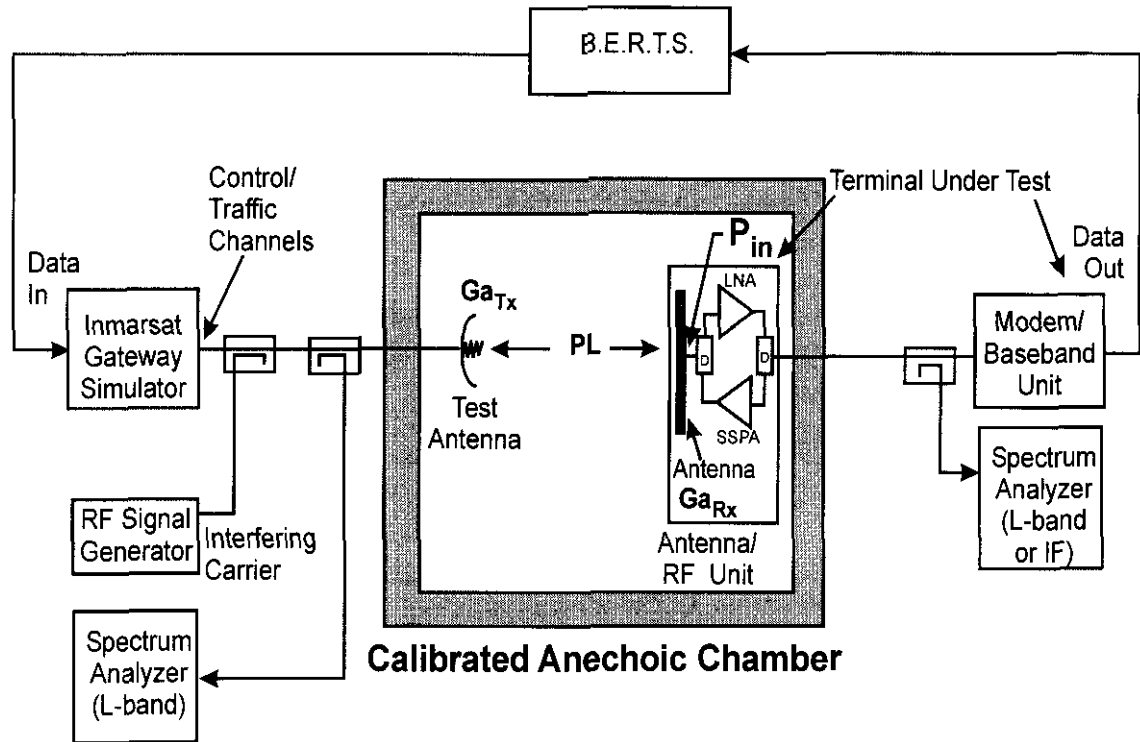
In Fig. 2, the received power level P_{in} at the antenna output of the terminal under test must be calculated indirectly using the test antenna gain Ga_{Tx}, terminal receive antenna gain Ga_{Rx}, and the path loss PL inside the chamber. **It becomes, therefore, imperative that the test antenna gain and chamber path loss be calibrated accurately, that the terminal antenna gain be known accurately, and that the terminal antenna boresight be oriented optimally toward the test antenna.**

III. Testing Considerations for Measuring the Overload Threshold of a MET based on a Bit Error Rate (BER) Measure: MSV recommends that the following items be addressed carefully to ensure meaningful test results:

A. **Measurements should be taken based on a variety of key variables.** To arrive at the appropriate E_b/N_0 operating point of a MET (prior to subjecting the MET to any interference), **for each of the various services provided using that MET-type,** the displayed signal quality of the MET (for the service to be provided and in the absence of interference) initially should be set at the level recommended by the manufacturer of the MET. **This level should be a typical level, NOT a worst-case level.** With the E_b/N_0 operating point appropriately set at the typical level, the overload threshold (onset of unacceptable BER for the service being evaluated) should be measured **as a function of frequency separation** (center-to-center) between the MET carrier and the interference carrier (a frequency separation increment of 50 kHz is recommended). For a given frequency separation, the overload threshold may be found by starting-out with a very low EIRP of the interfering carrier(s) and gradually increasing this EIRP until the unacceptable BER level is reached for the service being tested. The procedure will identify an "overload threshold as a function of frequency separation" signature for the MET and service being tested, and a frequency separation "guard-band" beyond which the MET's overload threshold stabilizes and becomes insensitive to any further increases in frequency separation between the MET and the interference carrier(s). After the initial overload measurements have been performed, as described above, **the typical Eb/N_0 operating point of the MET then should be increased by 3 dB, 6 dB, 9 dB, 12 dB, and 15 dB,** respectively, and the measurements should be repeated at the 3 dB, 6 dB, 9 dB, 12 dB, and 15 dB higher E_b/N_0 operating point, respectively, in order to provide an understanding of the extent to which an increase in the power assigned to the terminal will compensate for any increase in interference.

Some METs that are capable of packet data reception, may be capable of informing the system to reduce the down-link data rate in order to satisfy a Quality of Service (QoS) measure in the presence of higher interference (GSM's GPRS and EDGE packet data modes, for example, have this capability and some of the Inmarsat METs that the Commission plans to evaluate may also have this capability). As such, it is important to understand the ability of a MET to operate at a reduced (forward link) data throughput in order to withstand a higher level of interference while satisfying a desired QoS (such as BER) measure. If the Commission plans to test packet data capable METs (or any other type of MET that is capable of rate adaptation), an evaluation and quantification of the rate adaptation capability of the MET in the presence of interference is of importance in establishing continuity-of-service criteria in the presence of increased interference.

B. **The threshold BER value for a data service, or the threshold Frame Erasure Rate (FER) value for a voice service, that is used to specify an unacceptable level of interference, should be chosen in accordance with a service criterion that**

represents "useable" service not in accordance with an "ideal" service criterion. The BER should be measured after Forward Error Correction (FEC) decoding. For a data service, the BER measurements should be made at the terminal's data port output, after FEC decoding, since the BER at the terminal's data port output, after FEC decoding, is the BER that a user of the terminal will experience. Similarly, for a voice service, the FER measurements should be made at a point after FEC decoding to reflect the end-user's experience.

C. **For voice services, the Commission should perform standard subjective tests to determine the interference threshold that causes unintelligibility of voice.** Consistent with a test methodology that is based on identifying (for a given MET and service type) an interference threshold beyond which the performance of a MET is unusable, instead of an interference threshold that yields less than ideal performance, a subjective measure of voice intelligibility should be used to evaluate voice service performance subject to overload interference. Voice may continue to be intelligible beyond any FER threshold relating to "acceptable performance" that may be recommended by a MET manufacturer and/or Inmarsat.

IV. **Testing Considerations for Establishing the Overload Threshold of a MET based on a Measure of the 1 dB Compression Point:** The Commission's tests should include measurements on the overload threshold of Inmarsat METs in accordance with the specification of Appendix 1. These measurements are essential in order to determine the extent to which the 1 dB compression point of a MET is an accurate measure for specifying the MET's susceptibility to overload interference.

Appendix 1

Test Method for 1-dB Compression Measurements:

I.   Test Configuration:

MSV has employed two different laboratory test configurations depending on the physical structure of the Inmarsat terminal under test. For units where the antenna element is physically integrated with the LNA (Thrane & Thrane Capsat Mini-M models TT403034H and TT3022D), the combined antenna/RF unit is placed inside an anechoic enclosure along with a test antenna connected to a signal generator as shown in Fig. 1. An RF coupler is placed at the output of the antenna/RF-unit to provide a measurement point for received signal level:

Fig. 1: Test Configuration for Terminals Having Antenna Integrated with RF Electronics

Anechoic RF Enclosure
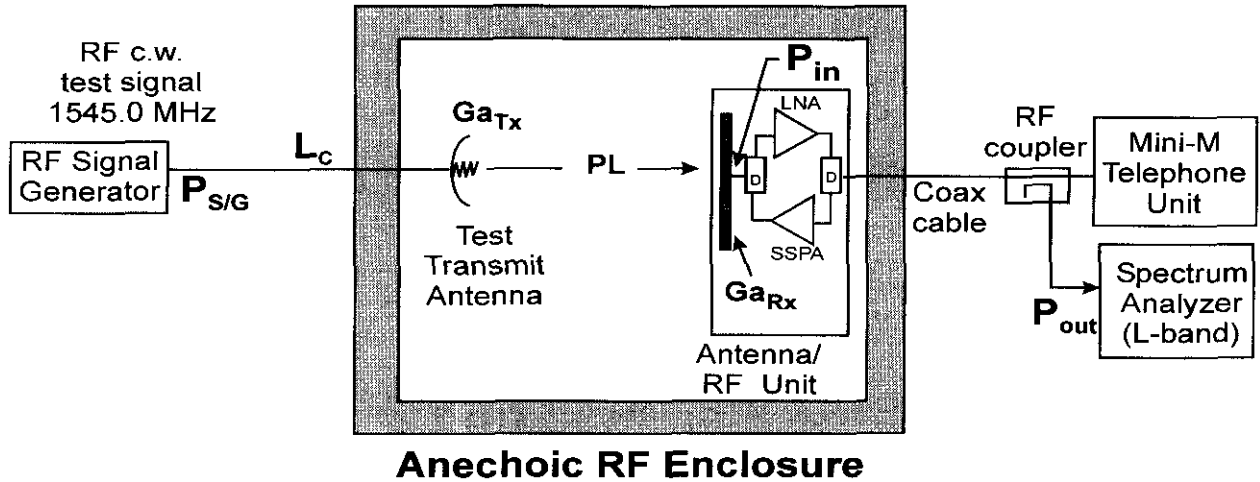
In the test set-up of Fig. 1, the received power at the antenna output, denoted P_{in}, is calculated as:

$$P_{in}(\text{dBm}) = P_{S/G}(\text{dBm}) - L_C + Ga_{Tx} - PL + Ga_{Rx} \qquad (1)$$

where:

$P_{S/G}$ = Test transmit signal level at signal generator output.

L_C = Cable/connector losses.

Ga_{Tx} = Test antenna transmit gain toward terminal receive antenna (dBi).

PL = Coupling loss between transmit and receive antennas.

Ga_{Rx} = Inmarsat terminal receive antenna gain toward transmit antenna (dBi).

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For terminals where the antenna can be physically disconnected from the front-end input (Nera Saturn Maritime Standard B), the hard-line test configuration shown in Fig. 2 is used:

Fig. 2: Test Configuration for Terminals Having Detachable Antenna
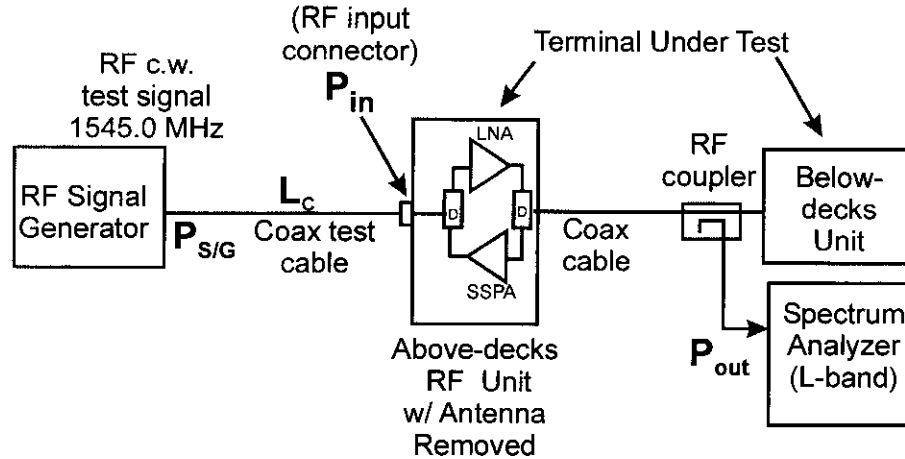
In this case, the front-end input power is:

$$P_{in}(dBm) = P_{S/G}(dBm) - L_C \tag{2}$$

II. Test Procedure:

1. With the terminal powered-on in either the Fig. 1 or Fig. 2 test configuration, a continuous wave (CW) test signal is generated at a frequency within the terminal's receive passband (1545 MHz), and fed to the receiver input. The signal generator level $P_{S/G}$ is initially set so that the received input power P_{in} is well within the receiver's linear range of operation. The input power level P_{in} is calculated using (1) or (2) as appropriate, and the corresponding output power P_{out} is measured through the test coupler and recorded.

2. The signal generator level $P_{S/G}$ is incrementally raised in steps of 5 dB. At each level, the input power P_{in} is calculated and output power P_{out} is measured and recorded.

3. When the receiver is operating in its linear range, the dB-increase in P_{out} will exactly match the increase in P_{in}. When the measured value of P_{out} begins to diverge from this dB-for-dB relation, the input step size should be progressively reduced to 1-dB steps or smaller so that the 1-dB compression point can be accurately determined. The 1-dB compression point corresponds to the value of P_{in} at which the total measured increase in P_{out} is exactly 1-dB less than total increase in $P_{S/G}$.